ART. VIII.—*Histoire de L'Astronomie ancienne et moderne De J. S. Bailly, dans laquelle on a conservé littéralement le texte historique de l'Auteur, en suprimant les details scientifiques, les calculs abstraits, les notes hypothétiques, peu utiles à beaucoup de Lecteurs, et aux Elèves auxquels ce Livre est spécialement destiné.* 2 vols. 8vo. pp. 866. A Paris, Chez Bernard, 1805.

ASTRONOMY is certainly the boldest and most comprehensive of all our speculations. It is the science of the material universe considered as a whole. Though employed upon objects apparently withdrawn from the sphere of human action and pursuit, it teaches us, nevertheless, that these objects materially affect, nay constitute, our physical condition. The wide-spreading firmament, while it lifts itself above all mortal things, exhibits to us that luminary, which is the light, and life, and glory of our world, and when this retires from our view, is lighted up with a thousand lesser fires, that never cease to burn, that never fail to take their accustomed places, and never rest from their slow, solemn, and noiseless march. Among the objects more immediately about us all is vicissitude and change. It is the destiny of terrestrial things to perpetuate themselves by succession. Plants arise out of the earth, flourish awhile and decay, and their place is filled by others. Animals also have their periods of growth and decline. Even man is not exempt from the general law. His exquisite frame, with all its fine organs, is soon reduced to its original elements, to be moulded again into new and humbler forms. Nations are like individuals, privileged only with a more protracted existence. The firm earth itself, the theatre of all this change, partakes in a degree of the common lot of its inhabitants, and the sea once heaved its waves where now rolls a tide of wealth and population. Situated as we are, in this fleeting, fluctuating state, it is consoling to be able to dwell upon an enduring scene, to contemplate laws that are immutable, an order that has never been interrupted, to fix, not the thoughts only, but the eye, upon objects that after the lapse of so many ages, and the fall of so many states, cities, human institutions, and monuments of art, continue to occupy the same places, to move with the same regularity, and to shine with the same pure, fresh, undiminished lustre.

As the heavens are the most striking spectacle that presents itself to our contemplation, so there is no subject of philo-

sophical inquiry, which has more engaged the attention of mankind. Its history carries us back to the earliest times, and introduces us to the languages and customs, the religion and poetry, the sciences and arts, the tastes, talents, and peculiar genius, of the different nations of the earth. The ancient Atlantides and Ethiopians, the Egyptian priests, the magi of Persia, the shepherds of Chaldea, the bramins of India, the mandarins of China, the Phenician navigators, the philosophers of Greece, and the wandering Arabs, have contributed to the general mass of knowledge and speculation upon this subject, have added more or less to this vast structure, the common monument of the industry, invention, and intellectual resources of mankind. They, whose imaginations have wandered up to the sphere of the stars, like those who have visited unfrequented regions on the earth, have left there, as in a sort of album, some memorial of themselves and of the times in which they lived. The constellations are a faithful picture of the ruder stages of civilization. They ascend to times of which no other record exists, and are destined to remain when all others are lost. Fragments of history, curious dates and documents relating to chronology, geography, and languages, are here preserved in imperishable characters. The adventures of the gods and the inventions of men, the exploits of heroes and the fancies of poets, are here perpetually celebrated before all nations. The seven stars and Orion present themselves to us as they appeared to Amos and Homer. Here is consecrated the lyre of Orpheus and the ship of the Argonauts, and, in the same firmament the mariner's compass and the telescope of Herschell.

We remark further, that astronomy is the most improved of all the branches of human knowledge, and that which does the greatest credit to the human understanding. We have in this obtained the object of our researches. We have solved the great problem proposed to us in the celestial motions; and our solution is as simple and as grand, as the spectacle itself, and is in every respect worthy of so exalted a subject. It is not the astronomer only, who is thus satisfied, but the proof is of a nature to carry conviction to the most illiterate and skeptical. Our knowledge, extending to the principles and laws which the author of nature has chosen to impress upon his work, comprehends the future; it resembles that which has been regarded as the exclusive attribute of supreme intelligence. We are

thus enabled, not only to explain those unusual appearances in the heavens, which were formerly the occasion of such unworthy fears, but to forewarn men of their occurrence; and, by predicting the time, place, and circumstances of the phenomenon, to disarm it of its terror.

There is however nothing perhaps so surprising in this science, as that it makes us acquainted with methods, by which we can survey those bright fields on which it is employed, and apply our own familiar measures to the paths which are there traced, and to the bodies that trace them; that we can estimate the form, and dimensions, and inequalities, of objects so immense, and so far removed from the little scene of our labors. What would be the astonishment of an inhabitant of one of those bodies, of Jupiter for instance, to find that, by means of instruments of a few feet in length, and certain figures and characters, still smaller, all of our own invention, we had succeeded in determining the magnitude and weight of this great planet, the length of its days and nights, and the variety of its seasons, that we had watched the motions of its moons, calculated their eclipses, and applied them to important domestic purposes? What would be our astonishment to learn, that an insect, one of those for instance which serve sometimes to illuminate the waters of the ocean, though confined by the exercise of its proper organs, and locomotive powers, to the sphere of a few inches, had, by artificial aids of its own contriving, been able to extend its sphere of observation, to the huge monsters that move about it; that it had even attempted, not altogether without success, to fathom the depth of the abyss, in which it occupies so insignificant a place, and to number the beings it contains?

Since astronomy is thus connected with the development of our faculties, it may be a matter of some curiosity to notice a few of the more important epochs in its history. It is considered as properly originating with the Greeks, who were called to Alexandria by the Ptolemies. Before the foundation of this school, no general scheme, with respect to the study of the heavens, had been devised, no enlarged notions had been formed, no means had been found out for precise and accurate determinations, nor could astronomy be said to exist as a science. Those who pretended to study the heavens, were employed in vague notices of the most obvious phenomena. '*On such a day, an hour after sunset or two hours before*

midnight, the moon was one half or one third eclipsed, to the north or south. A planet eclipsed a star, or was distant from a star one or two moons, or one or two cubits. This was the kind of observations made by the Chaldeans and others, before the time above referred to. It is to the Greeks, that we are indebted for every thing that reduced the study of the stars to the form of a rational and philosophical inquiry. They conceived the plan which has now been pursued for two thousand years. They projected the work on which so many hands have been employed. They invented instruments and methods which are the basis of those still in use. They are the authors of that geometry, which is our pride and boast, the science of extension, and of the relations of lines and angles, the most powerful and the most indispensable of all instruments, in an enterprise of this nature, and the most purely a creation of all productions of the human mind. It is in fine to the philosophers of this school, that we are indebted for the first example of a regular course of observations, for those determinations which make the elements and groundwork of the science. The magnitude of the earth, the length of the year, the obliquity of the ecliptic, the precession of the equinoxes, are among the objects sought and attained with more or less success. The distances and dimensions of the sun and moon were also discussed; but what seemed at this time the most daring exploit of all, *rem etiam deo improbam*, according to Pliny, was the making a catalogue of the number and positions of the stars. This was undertaken and executed by Hipparchus, who has more claim, than any other person, to be considered as the founder of the science. Others had distinguished themselves by particular researches or insulated observations. Hipparchus took a comprehensive view of the whole subject, collected and combined the detached results of those who preceded him, re-examined every thing, and built up a body of sound doctrines upon the sure basis of observation and a refined geometry. The fruits of these immense labours were preserved by Ptolemy, the last ornament of this school, and, together with some additions of his own, were digested into the form of a treatise, probably the first deserving this title, certainly the oldest now extant. In this venerable work, the united product of so many generations of philosophers and learned men, to which so many powerful minds have made their feeble contributions, and toward

which so many have laboured in vain, or worse than in vain, we recognize the fairest and noblest specimen of the scientific attainments of the ancients; we here find their amount of knowledge, and their final opinion, with regard to this great problem, which has exercised the skill and ingenuity of so many people of different ages and countries.

The destruction of this renowned seat of learning by the Arabs, was followed by a long and barren period. At length this very people were the first to catch the spirit which seemed still to linger near the consecrated spot. They attempted to collect and rekindle at Bagdat the remains of that science, which still slumbered in the ruins of Alexandria. They took advantage of the lapse of several centuries to correct certain results transmitted to them. With the improvements and additions, that were now introduced into the science, are associated the names of Almamon and Albitegnius. Moreover about this time Ulugh Begh, a prince of Tartary, and grandson of Tamerlane, improved the tables of Ptolemy, and made a new catalogue of the stars. This observer is remarkable, as being the last of any note, who contributed to the advancement of the science in this quarter of the world.

We are now to take a view of the science in a new region of the earth. It had hitherto flourished only in mild climates and under serene and brilliant skies. It may be considered as indigenous in the East, but, like many plants of the same climate, it was more luxuriant than fruitful. In Europe it never sprung up spontaneously. It was transplanted thither from Asia, and as is sometimes the case with exotics, it has thrived better by assiduous and judicious cultivation, in an unpropitious soil, than it had done without this care, in regions the most favourable to its growth.

Astronomy has now been an object of attention in Europe but a few years, as it were, compared with the whole period of its history, and it has assumed a tone and character never before conceived by its most devoted friends. The first material step in its progress was the establishment of the present arrangement of the sun and planets by Copernicus. This doctrine, to be sure, was held by Pythagoras, and, as if the soil had some connexion with it, on European ground. But it was now presented in a new and stronger light, with its leading features more fully and distinctly unfolded.

It is remarkable, that this doctrine should, in so many in-

stances, have exposed its authors and defenders to persecution. Pythagoras, we are told, made it known only to a select few; but his disciple Philolaus, who had the courage to teach it publicly, was obliged to fly in order to escape the odium it excited. Two and a half centuries afterward Aristarchus ventured to maintain the same opinion and met with a similar fate. 'He was accused of impiety, for having disturbed the repose of Vesta, that is, of the earth, and of the gods Lares the protectors of the universe.' Copernicus meditated upon the subject for many years, before he undertook to give his thoughts to the world, and scarcely surviving the publication of his work, he left to others to receive the shock, that awaited those who espoused it. Galileo could not resist the accumulated evidence, that presented itself to his enlarged and philosophic mind, in favour of this refined scheme, and was accordingly destined to bear the whole weight of indignation that was ready to burst upon the disturbers of a prejudice so old and so deeply rooted. He was arrested and seven cardinals clothed with the authority of the church sat in judgment upon this great apostle of natural truth, and solemnly pronounced the following *arret*; 'To maintain that the sun, immoveable and without local motion, occupies the centre of the world, is a proposition absurd, false in philosophy and heretical, since it is contrary to the testimony of the scriptures. It is equally absurd, and false in philosophy, to say that the earth is not immoveable in the centre of the world; and this proposition, theologically considered, is at least erroneous in faith.' vol. i. p. 144.

With the name of Galileo we connect the first use of the telescope, and the commencement of a new and most brilliant era in the history of astronomy. The defect of the natural organ with respect to the objects of this science had never been recognized. We had gazed upon them without comprehending what we saw. We had cast a vacant eye over the splendid pages of this volume, as children amuse themselves with a book, which they are unable to read. We had caught here and there, as it were, a capital letter, or a picture, but we had failed to distinguish those smaller characters on which the sense of the whole depended.

It is not the least of the advantages of this wonderful invention, that it has taught us the importance of those means of improvement and enjoyment, which are placed within the

reach of our own ingenuity and skill. No one surely would have dreamed of procuring such an aid to the natural sight, any more than of creating a new sense. It would have seemed like changing the law of our being, and the condition in which we are placed. We have, by means of this instrument, emerged as it were from a prison. The mind has effected its enlargement, as an insect bursts its little tenement, and flutters through the free air, and over the gay fields.

Another change in the science, of the first importance, was wrought by the genius of Kepler. The discoveries of this great man, though less calculated to strike the common observer than many others, are notwithstanding the foundation of all the great improvements of later times. They are the first steps in that rapid career, which has placed Europeans so far before all others who have cultivated this science.

The history of astronomy has been divided into two periods, one extending from its origin to the time of Kepler, and the other comprehending the interval that has since elapsed. During the first of these periods all investigations proceeded upon the supposition, that the planets moved in circular orbits. Kepler, after the most intense and persevering application to this subject, had the rare merit of disabusing the world of this prolific error. He found that the true form of the planetary orbits was the ellipse. He detected also the law of the inequality of their motions, and the relation between the distances of these bodies from the sun, and the times in which they complete their revolutions.

'It is the privilege of great men,' says Bailly, 'to change received ideas and to announce truths, which spread their influence over future ages. By these titles Kepler deserves to be regarded as one of the greatest men that has appeared upon earth. By the ascendancy of his genius he commenced our superiority over the ancients; he is the true founder of modern astronomy, and is a present which Germany has made to Europe.—Kepler proceeded, by removing one prejudice after another; it is by successive steps, by repeated efforts, that one renders himself worthy to tear the veil extended over twenty centuries, and to become the light of successive ages. Kepler, instructed by tradition, and imbued with a philosophy, the basis of which was simplicity, was to seek truth only through multiplied facts, and complicated hypotheses. It was necessary to get rid of a great number of errors, to substitute forced suppositions for absurd ones; a long series of ages was to be traversed in order to arrive at the simple

principles;—the secret. thus detected, had never been revealed; this discovery was a favour from heaven. It is the privilege of genius to penetrate into the essences of things, to ground truths upon the foundations of nature, and to render them as durable as her works.

'Kepler's life, so occupied, so glorious for himself, so useful to the sciences, was still disturbed by the care of providing for his family. He had a small pension, but on account of the scarcity of the times, it was not paid him. He had to make journeys to solicit it, and thus, consuming time that was so precious, his mind was harassed, and his strength wasted by anxiety. He was reduced for eleven years to absolute want. He died at the age of fifty-nine: leaving to his wife and children nothing but his fame.' pp. 93, 140.

The last and most important of all the revolutions, that have taken place in the science, is that achieved by Newton. There is no other instance of so signal a change in the opinions and pursuits of the philosophic world. It may be compared to those great and rapid conquests, by which new boundaries and new laws have been given to states and kingdoms, and new directions to the industry and active employments of men; with this difference, however, that these have been made by violence, and with the aid and co-operation of others, while the revolution in the sciences, effected by Newton, was the silent, solitary work of an individual.

It has been said, that Newton was as fortunate, as he was great. It is undoubtedly true, that there is a particular epoch in the progress of discovery, more favourable than any other, for the exertion of great talents, and calculated to reflect peculiar glory upon him whose lot it is to fall upon it. In the gradual approaches of day, there is no one moment that is easily distinguished from those which precede and follow it, but the first bursting of the sun above the horizon is an event that is marked by every one. If Newton had been appointed to fill the place of Hipparchus or Kepler, he might not have done more than either of them. Coming to the work, as he did, he availed himself of all the talents and exertions of those who preceded him. He looked around and saw the materials for a beautiful edifice, wrought with immense labor and skill, by different persons, at different times, and in different parts of the earth. It required the genius of a master-builder, to perceive the relation and fitness of

parts so detached from each other, so numerous, so covered with rubbish and the rust of time, and needing so much to be supplied to connect and complete the whole. Michael Angelo said he would place the Pantheon in the air. Newton has placed in the view of all the world and all future ages, the great works of his predecessors, in one vast imperishable monument of his genius.

It is worthy of remark, that though the English nation is so justly proud of this illustrious philosopher, it has left it to foreigners to do justice to his character and his writings. Among these there are none of the popular class whose account is more full and more eloquent than that of Bailly. The following is selected as a specimen.

'In speaking of Newton,' says he, 'who was alone and modest, who did not seek to appear, who did great things with simplicity, it is necessary to be as simple as he was, as nature whom he followed.—We shall not speak of his studies; he was born rather to invent than to study; he is not seen, like others, advancing by efforts and by failures. Thus Fontenelle applies to him a thought of the ancients, respecting the noble river which fertilizes Egypt, the source of which was a long time unknown. *Men are not permitted to see the Nile in its feeble emerging state.*' p. 300—303.

'Newton was at mature age, when he published his immortal work. He had been revolving the subject in his mind, and maturing the truths during twenty years. Nothing but excessive modesty could have so long prevented his assuming such a superiority over the most distinguished men of his age. So rare a merit ought to be preserved in history. Justice requires, that men should be known by their virtues; and pride may learn by examples, that modesty is almost always inseparable from true greatness.

'Newton, more than any man, owes an apology for his elevation; he took a flight, so extraordinary, and returned with truths so new, that great address was necessary in those who would resist these truths. Doubtless other discoveries were necessary to prepare the way for Newton. Particular views lead to more general ones. Hooke pronounced the name of attraction; he thought it was univeral; he asked what were its laws. As to facts and principles, Kepler had given the laws of motion of the celestial bodies, Galileo those of the descent of heavy ones near the earth, Descartes had announced the centrifugal force, Huygens had established its principles and variations; such are the steps by which Newton rose. It is thus that the mind of one age is formed by that of the preceding. But past ages had left errors as well as

truths; a singular talent was necessary to make the discrimination, and to call to its assistance all the parts necessary to so great a design. It is a beautiful sight to see Newton moulding the earth to its proper shape; saying to the tides, hitherto shall ye come, and no farther; chaining the planets to an immoveable centre, and prescribing limits to the eccentric wanderings of comets. How elevated his rank, how far removed from all who have preceded him in the same career!

'Newton was as singular for the character of his mind as for its superiority; it was pure and without alloy. Genius for the most part is ardent and passionate; it seems to require the impulse of motion, in order to rise. That of Newton was great without passion, and tranquil without losing any of its activity. There is no appearance of effort in what he does; he employs one truth to develope another; he seems to have made use of his genius merely to transport him to the centre of nature, where all the rays of truth meet; he relates as a spectator, what he saw.

'Newton had acquired all his glory by the time that most men begin their career. He passed the rest of his life in civil employments, in reaping the fruits of his labours, in receiving the esteem and admiration, which were so universal. Rewards and titles were heaped upon him, which did less honour to the man, who received, than to the nation, who conferred them. The eulogy of the English will always find itself connected with that of Newton. This nation has the credit of discerning merit, and of rewarding it with admiration; talent has a rank in it, and becomes the object of a durable homage. The genius of Newton perhaps the most rare, that any country, or any age has produced, excited a general enthusiasm. His philosophy was that of England, all her distinguished men were his disciples, the whole mass of her enlightened citizens, freest in a free country, chose him for their chief and dictator, and the nation rendered him a kind of worship. This great man shewed still his superiority by preserving his modesty; he never abandoned it; the serenity of his mind was not disturbed by so many distinguished suffrages; he always possessed his soul; he was no less remarkable for this than for his talents. Having long enjoyed what is most valuable among men, virtue and glory, he at length closed his life in that peace which he had ever sought, and in that advanced age, which seems to be the recompense of virtue, and the consequence of a tranquil life.' vol. ii. pp. 300—327.

In speaking of the origin and progress of astronomy, we have taken no notice of a favourite hypothesis of our author, respecting the very great antiquity of this science.

'In passing, says he, over the history of ancient astronomy we find only relics, we meet with nothing but the vestiges of a ruined system, of a primitive institution, the splendor of which is attested by what remains. The parts, by which these relics were originally connected, are now destroyed, or lost in the obscurity of time. We have not been governed by the spirit of system in the idea we have formed of an ancient state of the sciences, changed and effaced by some natural convulsion, or political revolution; it is the result of a critical examination of facts, and a careful comparison of such as are related to each other. The example of revolutions, of which some account still remains, shows the possibility of others, of which the tradition may be lost. We are in this respect situated like a person, who should be transported suddenly to the banks of the Euphrates. In the midst of those plains, to him new and unknown, the spectacle of vast ruins, in part concealed by vegetation, or covered with earth, the superb columns, remaining erect to show the heighth of the edifices to which they belonged, the shattered remnants of wealth and magnificence, the sculptured marble, covered with inscriptions, would immediately suggest to him the idea of a large city; he would know it was Babylon. The plan, the disposition of the buildings, the general character and effect of the whole, would no longer remain; but in the details, the work of art, in the immensity of the edifices, the fruits of riches and power, he would recognize the ancient residence of a numerous and civilized people.' vol. i. pp. 187, 188.

It is contended in proof of what is here advanced, that the knowledge remaining among the most ancient people, of which we have any account, was not of an elementary nature, was not that which would first suggest itself to persons just beginning to learn, but was rather the detached portions of a highly improved system, it was such as would most naturally be retained by nations, who had ceased to cultivate it. We find, for instance, the Chaldeans, Indians, and Chinese, from time immemorial, in the possession of methods for calculating eclipses, which they blindly followed without any idea of the principles on which they depended. These nations, it is maintained, thus possessing the same important methods without the industry and talents necessary to discover them, must have derived them from their common ancestors, or from some active, ingenious people, like the present Europeans, who had cultivated this science long enough, and successfully enough, to form tables of the motions of the heavenly bodies.

'Is it asked,' says our author, 'how this knowledge was preserved and transmitted; we answer that the columns, covered with hieroglyphical characters, are the records which have survived the deluge. These monuments of the ancient inhabitants of the earth were undoubtedly very numerous in Asia. It is in the part of the world first settled, that these original documents are to be looked for. The columns of Egypt, on which Thaut engraved the principles of the sciences, are only copies, which have become originals now that the others are forgotten.' p. 10.

Among the relics of the antideluvian astronomy supposed to be retained, by the oriental nations, are mentioned particularly some remarkable astronomical periods.

'The month of the moon, the year of the sun, we are told, were exactly determined; the revolutions of these bodies had been combined in a period of two hundred and twenty-three months, which supposes a knowledge of the inequalities of the moon, in a period of nineteen years, the golden cycle reinvented by Meton, in a period of six hundred years, the exactness of which is extolled by Dominique Cassini. There are, indeed, many others produced by the course of the stars. The obliquity of the sun's path had been recognized and determined, the heavens had been divided into constellations, the zodiac into twelve parts according to the course of the sun, and into twenty-eight according to the course of the moon. In fine, a degree of the circumference of the earth had been measured, and made use of to determine with precision the entire extent of our globe.—Such knowledge can be the result only of many and long continued observations.—To the above particulars, we may add two opinions, which seem to belong to ancient times; one is that of the return of comets, and the other, that of the true arrangement of the celestial bodies [the Copernican system.] These could have proceeded only from a sound philosophy, aided by a long course of observations, and especially from a philosophy sufficiently matured to have removed the errors that cover truths so remote and refined.' vol. ii. pp. 448, 449.

As a further proof that the astronomy of the most ancient nations had not a distinct, separate origin among them, but was derived from their common ancestors, we are reminded of the singular conformity, that has been found to prevail so universally, as to the first principles of the science. The different nations into which the human race was divided had parcelled out the heavens in the same arbitrary and whimsical manner. We find every where a zodiac, divided into

the same number of constellations, and distinguished by similar names.

'How surprising it is that the name of Great Bear should have been given to the same northern constellation by a nation of America [the Iroquois], and by the most ancient people of Asia, from whom this name has passed to us. This constellation does not resemble a bear, nor any other animal.—What a surprising coincidence, that two people should agree in a thing so perfectly arbitrary.' vol. i. p 370.

But what is more remarkable still is, that the names of the planets are so generally applied to the days of the week.

'This is perhaps,' says Bailly, 'the most singular proof of the antiquity of astronomy, and of the existence of this people anterior to all others. The planets, which preside over the days of the week, were arranged in the order, which still exists among us, namely, first the Sun, then the Moon, Mars, Mercury, Jupiter, Venus,* and Saturn. This is found to be the same among the ancient Egyptians, Indians and Chinese. The order is not that of the distances, magnitude, or brightness of the planets; it is an order that is apparently arbitrary, or which, at least, is founded on reasons not known to us. It is not to be supposed, that chance should have conducted these three nations independently, first to the same idea of giving to the days of the week the names of the seven planets, and then of giving these names according to a particular arrangement selected from a thousand others.' vol. i. p. 27.

But our author draws his chief argument in support of this hypothesis from the present state of astronomy in India.

'The people of this country, we are told, may be regarded as the depositaries of the most precious remains of antiquity. These remains, moreover, are as pure, as they are ancient; for, in the indolence of the Indians, they possess without acquiring, and their pride prevents them from adopting any thing from others. They know nothing of causes; we find in one place the practice of observations without results, in another results without observations, methods, which the most intelligent employ without com-

* Tuesday, Wednesday, Thursday, and Friday with us are derived from Tuisco, Woden, Thor, and Freya, the Saxon names of Mars, Mercury, Jupiter, and Venus. The days of the week in the East still correspond to ours. *Soma-var*, for instance, of the Indians, which signifies *day of the moon*, answers to our Monday. 'Yet no man,' says Sir William Jones, 'ever imagined that so remarkable an arrangement was borrowed from the Goths or Germans.'

prehending them, as foreigners retain a few phrases of a language they do not understand. From the total ignorance that prevails with regard to the principles of the science, we infer that the methods they use, are not the work of the people who practice them; it is not to be believed, that those principles on which they depend, could have been forgotten. The people may have lost the recollection of certain historical facts, and particular insulated branches of knowledge. But a science consists of a body of ideas, that mutually preserve and defend each other. It follows, therefore, that this kind of information, which they possess, has existed with the Indians from time immemorial.—We think that they have existed as a people, from the year 3553, before the christian era. It is the date deduced from the reign of their kings. But according to their own calculation their antiquity is beyond all probability. They allow for the duration of the world 4,320,000 years, which they divide into four periods. The first, the age of innocence, lasted 1,728,000 years; the second, 1,296,000 years; the third, 864,000 years; and the fourth, the age of calamity, that which is now passing, and which they call *Cali-Yug*, is to last 432,000 years. It is evident that these periods of the Indians are the origin of the four ages of the poets. Never has truth blended itself with error, or rather with fable, in a manner more easy to be distinguished. *The small number of years of the last period, proves that it contains a true chronological epoch, which ascends to the year* 3102 *before the christian era.*

'That which does the greatest credit to the Indians, is their method of calculating eclipses. It is very expeditious and sufficiently exact. The Bramins seem to be machines mounted to calculate eclipses. Their rules are in verse, and they recite them as they proceed. They make use of *cauris*, a kind of shell which is adopted as a coin in India. This mode of calculating has the advantage of being ready and expeditious; but it does not admit of the process being reviewed. The steps are destroyed as the work proceeds, and if a mistake is made, it is necessary to begin anew.

'Although those who concern themselves with astronomy, that is, the Bramins, may have a just idea of the new and full moon, yet the people, plunged in the most profound ignorance, explain these phases in their own way. They suppose that the moon is filled with ambrosia, and that the gods come to take their repast there, and this is what causes the diminution of its light. The regularity of the return shews that the provision is carefully renewed, and that the gods have their appetites under good regulation.

'The Bramins make the earth the centre of the universe; they imagine seven worlds, which are the planets, among which the

earth fixed upon a mountain of gold, occupies the principle place. They do not appear to be acquainted with the diurnal motion of the earth; they think that the stars move, and that they are a kind of fishes, because they move in ether as fishes do in water. This idea, which is without doubt only a figurative explanation, is more just and philosophical than that of the ancient Greeks, who supposed that the stars were attached like nails to the solid, spherical shell of the heavens. They reckon nine planets, namely, the seven which we have, and two invisible dragons, which are the cause of eclipses.' vol. i. pp. 48—54.

'It is a singular fact that the Indians place the moon farther off than the sun That this opinion is not confined to the ignorant multitude, and that it is very confidently maintained, seems evident from the following incident. 'A Bramin of Tanjour, says Bailly, finding himself in prison with one of our missionaries, had long conferences with him, and he bore very patiently his refutation of idolatry, and all that he chose to say against the gods of the country; but when he saw that the missionary pretended that the sun was farther from us than the moon, *il se fâcha tout de bon*, he could bear it no longer, and refused to have any thing more to do with him.' vol. i. p. 55

'Notwithstanding all the absurdities of the Indians, which form so striking a contrast to their refined methods of calculation, their pride is not less extraordinary. "They despise us Europeans," says M. Legentil, "and regard us as little better than savages" Proud of their cast, and of the antiquity of their knowledge, they can scarcely imagine that we cultivate the sciences, that we have universities, and academies as they have. This character of the Indians is a natural consequence of their ancient superiority; heirs of a primitive people, from whom they have received their sciences, they enjoyed for a long time the privilege of being the only enlightened nation in the world.' vol. i pp. 49—56.

The accuracy of the astronomical periods and tables of the Indians could, it is presumed, be attained only by a more active, ingenious and persevering people, and by means of instruments, methods, and theories, that are no longer to be found, and of which there is no account or tradition. Hence, it is inferred, they must have been derived from a very ancient people, whose history and even name, are now lost. The present astronomical works of the East are, it is contended, the fruits of a more enlightened age, when the science was cultivated, as it is now cultivated in Europe; and the present race of Indians are like our almanac makers, able

to follow rules, which they never could have invented, and to obtain results, that they never would have dreamed of without the instructions of their masters.

The present state of astronomy in the East, particularly in India, is certainly a very singular phenomenon. It is but lately that we have been made acquainted with it, and we have probably yet much to learn respecting it; we are in want at least of more information before we can very satisfactorily make up our minds on the question as to its origin and antiquity. It seems to be agreed that the Indians have more accurate tables of the motions of the heavenly bodies, than we have known in Europe till within a short period, and that they have been in possession of them for a long time, and that they are constructed so differently from ours, that it is no ordinary labour for our best astronomers to decipher them. Their tables recognise the equation of time and the distinctions of solar and siderial year, solar and siderial day; they imply a knowledge not only of the obliquity of the ecliptic, of the precession of the equinoxes, of the motion of the nodes and apsides of the moon and planets, of the equation of the sun's centre, but of many minute irregularities in the celestial motions, that seem altogether beyond the skill and means of the present inhabitants of the country. It is true that they have amongst them a knowledge of arithmetic, of elementary geometry, and plain trigonometry, but are without the doctrine of the sphere, so essential to precision in all astronomical calculations. They appear moreover to be destitute not only of the telescope, but of all instruments of any value for measuring angles and time.

It is from facts of this kind, so difficult to reconcile upon any hypothesis, that Bailly infers the great antiquity of the Indian astronomy. But he undertakes to prove, by internal evidence, drawn from the tables themselves, that they must have been constructed about five thousand years ago. They claim to be thus ancient; they refer to an epoch 3102 years before the christian era, when, according to them, the planets were all in conjunction. Our own tables are resorted to as a test of the truth of this claim, and the result of the calculation is, it should seem, a confirmation of the hypothesis. It is contended, moreover, that there are certain elements in the Indian tables, far from being true now, but which were true, according to our theory of gravity, at the epoch supposed, and

must therefore have been the result of observations made at that time, since the possessors of these tables are without that theoretical knowledge which would be necessary to adapt them to the varying condition of the planetary orbits.

Not content with maintaining this enviable distinction of the nation in question, Bailly undertakes to show that the Greeks of Alexandria derived from this source no inconsiderable part of what we give them so much credit for discovering themselves, and that we ourselves, confessedly the pupils of the Greeks, are thus under obligations to this highly favoured people, and that we should do well to avail ourselves still farther of these valuable treasures, which have been so long concealed from the world.

The question as to the origin of a science, in many respects so matured, and yet so unlike that of any other nation, among a people apparently destitute of the means and ability to acquire it, has called forth much learning and ingenuity, without furnishing the means for a very satisfactory decision. The discussion would lead us into long and minute details and calculations in which few of our readers we fear would find interest enough to follow us. Since the time of Bailly, however, considerable light has been thrown upon this subject, which has tended more and more to expose the extravagance of his hypothesis, and to show how much it owed to the singular address and eloquence with which it was defended.

According to the Indian astronomers the planets were all in conjunction 3102 years before the christian era, and this epoch, says Bailly, was founded upon actual observation. Now from our own tables which are the best means we have of judging, it is necessary to except one of the planets entirely, and to allow a space of seventeen degrees, as the smallest limits within which the others were comprehended. The Indian tables, we are told, apply to the state of the heavens at this epoch, and the proof is derived from our own tables and theories, which it is admitted by the best judges, are not to be depended upon for a time so remote. Of what value then is this kind of evidence ?

It is important to observe, that Bailly was not acquainted with the systems of astronomy in use among the Indians, or with the manner in which their tables are composed. It appears from the investigations of those who have long resided in the country, and who have had access to the best materials,

and best means of information, that the *Trivalore* tables used by Bailly, and which he supposed were about five thousand years old, 'were actually written and dated about five hundred and sixteen years ago; and that the mean annual motions given in that work were, *on the principles of the Hindu astronomy*, calculated to give the positions of the planets in the heavens at that time.—In most of the Hindu systems certain points back are fixed on, as epochs, at which the planets are *assumed* to fall into a line of mean conjunction with the sun in the beginning of Aries. From the points of time so assumed, as epochs, the Hindu astronomer carries on his calculations, as if they had been settled so by actual observation; and determines the mean annual motions which he must employ in his system, from thence, as [and which] will give the positions of the planets in his own time; as near as he is able to determine the same by observation.'*

This explanation of the Indian epoch appears farther probable from the practice of other astronomers. Ptolemy makes use of the era of Nabonassar, which began about 800 years before his time. Many modern astronomers have referred their calculations to the middle of the last century, and the epoch now used is the commencement of the present. Our Julian period is perfectly analogous to the Cali-Yug of the Indians; it ascends to 764 years before the creation, and the purpose of it is to make the cycle of the sun, that of the moon, and the indiction all begin at the same time.

But the question still returns, what is the age of the astronomical systems in question, and whence are they derived? If we ask the Indians themselves, they tell us, that they have eighteen works on astronomy, that were received by divine revelation, that the oldest of these, the *Suryá Siddhánta*, was given to them 2,164,899 years ago.† If we consult the works themselves on which these high pretensions are founded, we find no observations that are to be relied on, no documents to justify any very great antiquity. According to Mr. Bentley, who appears to have investigated this subject with great ability and fairness, the Indians have no book more than thirteen hundred years old, and they cannot be said to have had any considerable knowledge of astronomy earlier than the commence-

* Asiatic Researches, vol. vi. pp. 541, 542.
† Asiatic Researches, vol. vi. p. 540.

ment of the sixth century of our era.* The *Suryá Siddhánta* is generally acknowledged to be their most ancient astronomical work, and its age is deduced with great probability from internal evidence. It seems fair to presume that the tables would be more exact for the time when they were actually constructed, than for any other; and the computation made upon this assumption for the several planets independently gives for the largest result, 1105 years, for the smallest 340, for the mean of the whole 731 years, as the age of the above work. We should conclude from this that it was written about the middle of the eleventh century.

'But independent of all calculations, says Mr. Bentley, we know from Hindu books the age in which *Suryá Siddhánta* was written and by whom. In the commentary on the *Bhasvoti*, it is declared, that *Varáha* was the author of the *Suryá Siddhánta*. The *Bhasvoti* was written in the year 1021 of *Saka* [A. D. 1099] by one *Sotanund*, who according to Hindu accounts was a disciple of *Varáha*, and under whose directions he himself acknowledges he wrote that work. Consequently *Varáha* must have been then alive or else a very short time before it, which agrees as near as it possibly can be with the age above deduced.'†

From the best information we can obtain, therefore, there is little reason to believe that the Indians were in a condition to afford any valuable instruction to the Greeks. On the contrary, there is every reason to believe that they had very little to impart till four centuries after the time of Ptolemy, and that their present astronomical works of the earliest date and greatest authority were not written before the middle of the eleventh century. At this time astronomy had been revived and cultivated for more than a century by the Arabians, had passed from the Arabians to the Persians, and from the Persians to the Tartars. What was there to prevent its passing into India? It is worthy of remark that the tropical year of the Indians is very nearly the mean between that of Ptolemy and the one used by Albitegnius. The same is to be observed with respect to the equation of the sun's centre. We have no doubt that the Greeks are entitled to that which we ascribe to them, because they have furnished us with the observations, the instruments and methods by which they attained it. This

* Asiatic Researches, vol. viii. art. 6.
† Asiatic Researches, vol. vi. p. 577.

evidence is for the most part wanting with respect to the Indians. Perhaps it is yet to be learned. They appear to have many books relating to astronomy. They have a better arithmetic than the Greeks. Their algebra amounts to about as much as is taught in our public seminaries. These are not borrowed from the Greeks. Their astronomy also has strong marks of originality. It is not easy to imagine how they could have acquired it, with their means and their habits. On the supposition that it is derived from their neighbours, it is scarcely less difficult to conceive how they could have disguised it to such a degree. There is no doubt that they were acquainted with certain astronomical periods, that they cultivated astronomy to a certain degree, long before the time of which we have been speaking, and there seems to be as little doubt, that their present tables have been formed, or at least corrected, in modern times.

There is on the whole no prospect we think, of our deriving from the East any accession to our present stock of astronomical science; and the question seems reduced to a matter of curious speculation merely. We regret that the slight attention we have given it has left us so little room to notice some admirable discourses which terminate the work before us, and constitute not the least considerable part of its value. The first of these discourses is upon the origin of astrology, in which the author undertakes to refute what he conceives to be a prevalent error upon this subject.

'It is said that astrology is the daughter of ignorance and the mother of astronomy. It is thus that ideas are confounded. Astronomy is certainly the oldest. It is astronomy, that is the wise mother of a foolish daughter. It was necessary to know the stars before we could attribute to them any influence over us. It was necessary to have an idea of their motions and revolutions, before we could refer to them the destinies of men, and the chain of events in one's life.

'It is no less a mistake to suppose that astrology arose from ignorance. Astrology prevails more undoubtedly in barbarous times, when credulity joins itself to the natural curiosity of man. Astrology flourishes in the midst of ignorance, as in its natural soil But ignorance never produced the germ of evil which it nourishes. Ignorance is a passive state. The sciences, arts, fables, errors, prejudices, superstitions, evil as well as good, all come from genius. A single luminary by its heat and attraction

spreads life and motion through the universe. Genius is the sun which gives activity to the moral world.

'There are two kinds of astrology, natural and judicial. The object of the former is, from a knowledge of the causes acting upon the earth and its atmosphere. to foresee and announce the changes of the seasons, rain, winds, cold, heat, abundance, scarcity, diseases, &c. The latter is occupied with objects still more interesting. It delineates at the moment of our birth or some other moment of life, the course we are to pursue. It determines the character we are to receive from the author of nature, and the passions which are to agitate us. It shows from a distance evil and good, the perils that await us, and the actions we are to perform. If it were a true science, man, too well acquainted with his destiny, would have only to repeat upon the stage of life the part he had learned.—It will be thought perhaps that ignorance, by perverting the principles of natural astrology, has given rise to judicial astrology, that it has subjected man as well as the atmosphere to the power of the stars, and made their influence extend to the storms of the passions and the vicissitudes of fortune, as well as to the inclemencies of the seasons. Indeed it seems very natural to say, it is the stars, the heavenly bodies generally, that produce winds, rain and storms, their influence combined with the action of the sun's rays, modify cold and heat. The fertility of the country, health and sickness, depend upon their good or bad influences. A blade of grass does not spring up, but all the stars contribute to its growth. Man breathes only the emanations with which the stars fill the atmosphere. Man as well as nature is subject to them. The celestial bodies must have an influence upon his will, upon the good and evil scattered in his path, and finally determine his death as well as his life. It is well that we can reason thus ; but it is not ignorance, it is not the people, who have taken this step. The idea respecting this subjection, which makes man only a blind instrument, is an abuse of the understanding. It is the imagination that deceives the reason. It should be carefully observed that judicial astrology is an observation, natural astrology a system. The people do not make systems ; it is the work of the learned, of philosophers who wander sometimes from the noble purpose of searching after truth. The transition from natural astrology to judicial supposes a principle which has not been perceived, one which confounds the soul with the body, mind with matter. Is a principle the work of the people ? Is it the people who have reasoned upon the two substances in order to confound them ? They either do not know or do not distinguish them.—

'When society had commenced, and civil institutions had given

some degree of enlargement and foresight to the thoughts, when industry had insured an easy subsistence, man, freed from his cares, began to know the evils of mind, the greatest of all evils; the present was no longer of any value; hope and fear carried him to the future; he felt the desire of knowing it; but he perceived at the same time, that the means of knowing it were not in his power. Whatever may be the propensities men have, some to credulity and others to abuse it, the art of predicting the future has not arisen from the design to deceive men. The idea of this art was a bold thought; the invention of the means, erroneous as they are, must have been the work of genius. Genius has imitators, but it is alone the author of original ideas. When it had once been made known to men that the future might be foretold by the motions of the stars, the desire of deceiving, and of deceiving without science and without calculation, gave rise to different kinds of divination, by the features of the face, by the lines of the hand, by grains of sand thrown at random, by the flight of birds and the entrails of victims; in fine, the dead have been invoked, that which is no more has been appealed to concerning that which is yet to be.—It would be easy to show that all vulgar errors, the prejudices of the people, arise from philosophical ideas, misapplied, and perverted by tradition. Local and tutelary divinities were undoubtedly only the emblems used by philosophers to designate those second causes which depend upon the universal cause. The two principles, adored and feared in Persia, represent physically the elements that oppose each other, morally the contending passions. This idea is borrowed from the natural world, where all is at war. The circulation of matter the renewal of beings under new forms, gave rise to the doctrine of metempsychosis, which was transferred from material to intellectual beings, when it became desirable to reconcile this dogma with the immortality of the soul.' vol. i. pp. 162—170.

The other discourses of our author treat of the progress which astronomy has made, and which it may yet be expected to make, of the manner of writing a history of this science, of the origin of the constellations, of the nature of the stars, &c. These abound with original reflections, and like all the other parts of the work, are distinguished by a style and manner that are rarely found in treatises upon these subjects. The following view of the science of geometry will serve to illustrate these remarks.

'All things which exist in the universe, either at the same time or successively, have extension for the mode of their exis-

tence. Space, which embraces all points, all places, all the bounds of the physical world; motion, which passes over this space, belongs to it, is measured by it and seems to resemble it; time, which is marked by the succession of things, which exists from their commencement to their termination, which embraces the universe in its changes, as space contains it in its permanency, every thing is extended merely; physical extension which is before us, which the eye can distinguish and pass over, intellectual extension, which man can render present to his mind and which can be perceived and measured by the understanding only; see the province of geometry, it is here that it is great, that it is vast as the universe; miraculous work of human reason! Men have here concentrated all the ideas of order and justness that they have received from the heavens. If it has its limits like the human mind, in like manner it always rises with it, and from its elevation surveys all times and all places, measuring equally the portions of fleeting duration, and those of present visible matter.

Geometry was formerly only the art of measuring land and fixing its boundaries. It was humble and contracted. It had nothing great but its name. Thus Plato laughed at the arrogant title it assumed of *measure of the earth*, at a time when the earth was almost entirely unknown It was not long before this science made rapid progress in the hands of Plato himself and his disciples. It had as yet been applied only to surfaces. It was soon extended to the three dimensions of matter, and bodies were embraced by it. It was not long restricted to the consideration of straight lines, or to surfaces and solids bounded by these lines. From the sections of a cone were derived four curves, the circle, the ellipse, the parabola, and hyperbola. This new subject was an important step in the science. While the straight line advances by the shortest way, and seems to extend itself by equal and similar steps, directed with an invariable design to the same object, the curved line is composed of sinuosities and doublings, each step exhibits a change of purpose and tendency. Several causes must concur in its formation. It must evidently depend upon a law more complicated. This law is contained in certain fundamental properties. The Greeks studied and made known these properties, or the characters of the four curves we have mentioned, the most simple of all and indeed the only ones known at this time. They investigated them without foreseeing how important they were destined to become. When algebra was applied to geometry by the happy thought of Descartes, the properties which determine each curve were described by abstract signs, by algebraic characters. This union of the two sciences enlarged our resources. Newton, the inventor of the differential calculus, did not finish the work, which perhaps is not to be finished by

man. We see therefore that every thing reduces itself to the means which geometry furnishes. What is it which this science proposes? The measure of every thing which exists in the sensible world. That which exists is the work of nature, who has concealed throughout the simplicity of her principles under a variety of phenomena of nature, who, by opposing secondary principles, by making one thing act upon another, has appeared to disturb the prevailing uniformity and regularity, and has nowhere made two forms alike, or one that is regular. Man loses himself in this infinite variety. That which is much compounded is no longer regular with respect to him. He requires simple things and such as may be arranged according to his manner of conceiving them. We have undertaken, in order to study nature, to measure her works, by applying to them the figures of geometry, the regular forms of which we know the law. Able to multiply and vary these almost at pleasure, we can, by repeated attempts, imitate in our measures, the things we would know, we can approach in our copy of this grand model, almost as near as we please to the original, without ever reaching it perfectly. Indeed although the world presents no where lines absolutely straight, surfaces exactly plain, regular triangles, squares or cubes, perfect circles, ellipses, or parabolas, we measure by means of these figures an infinite variety of spaces that depart from them but a little; and when we endeavour thus to descend to details and to reach more nearly the truth of things, we require forms less simple and curvatures more complicated, to appreciate these very departures.

Moreover, when Newton applied geometry to the mechanical phenomena of the heavens, and raised the science to this great height, it became necessary to compare together things that are not of the same nature. Motion takes place in space, it lasts for a time, it has a velocity. Space, time, velocity, have no resemblance to each other. If velocity is the more rapid, according as the space passed over is greater, and the time employed less, what relation have time and space with each other? Yet geometry can be applied only to relations and equalities. We arrive at a comparison between things of a nature so different, by establishing for each of them a different modulus, a particular unit; and when we compare velocities, times and spaces, the comparison of each of these quantities with its particular modulus is always understood. We say for instance with respect to motions that are uniform, that when the times are equal, the spaces are as the velocities. These suppositions together with a few simple principles make the basis of the science of bodies in motion, a science created by Newton, and called dynamics, but which we have here comprehended under the general denomination of geometry.' vol. ii. pp. 378—383.

The other discourses of our author are distinguished by the same original manner of thinking and writing. This part of the work is free from that spirit of system which pervades and mars a very considerable proportion of the rest. The great excellence of the whole is, that without being superficial it is adapted to common readers and calculated to interest them. The author selected the most striking parts of his subject, and has presented them with great amplification, and great force and beauty of language. Many may here become acquainted with the leading truths of the science, and may be made to feel their importance and sublimity with very little exertion and little preparatory study.

ART. IX.—*A Letter on the Yellow Fever of the West Indies. By Daniel Osgood, M. D. Practitioner of Medicine in the city of Havana.* pp. 72. E. Bliss, New York, 1820.

SINCE the notice which was taken of the subject of the contagion of yellow fever, in our number for April last, we have received still further confirmation of the general correctness of the opinions which were then expressed. The circumstances connected with the appearance of this disease, in some of our cities the last summer, furnish very decisive evidence that it was not propagated by contagion.

In Philadelphia, where the health regulations were last year entirely founded upon the supposition of contagion, the good effects of acting upon a contrary belief this year, while the fever prevailed there, seem to have removed almost every fear of its possessing any such property. If it were true that those who are affected by it communicate the disease by its contagious poison to those about them, what method could be devised more calculated to spread the disease in every direction, than removing the sick, and scattering them among those in health? Yet it is well known to every one, how opposite to this was the result in Philadelphia, as it was in other places the previous year. It cannot be doubted that it is owing to the wise precaution of removing all persons, both sick and well, from the sickly neighbourhood, that the ravages of the disease were so limited and so speedily checked. Had the same course been adopted, that was pursued in the fever of 1793, there is much reason to apprehend that the disease would have been equally destructive.